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# NASA TECH BRIEF



## Study of Thermal Effects on Nickel–Cadmium Batteries

An investigation was made of space battery performance, with special emphasis on the thermal effects of nickel–cadmium batteries operating under continuous orbital conditions. During the program, a literature survey was conducted on the calorimetry and thermodynamics of electrochemical systems, specifically nickel–cadmium batteries. An improved isothermal continuous flow calorimeter was designed, constructed and calibrated. A 6 ampere-hour Gulton prismatic nickel–cadmium battery was tested under numerous orbital conditions. Cell data, such as oxygen pressure and the rate of heat generation, were collected and the changes in enthalpy ($\Delta H$) for the system undergoing the various processes were calculated.

The Gulton 6 A·H prismatic nickel–cadmium batteries, preconditioned and complete with Adhydrode electrodes, were subjected to a series of experiments which varied in depth of discharge, percentage recharge and number of cycles as follows:

(a) 79 cycles undergoing 25% depth of discharge and a 110% recharge.

(b) 74 cycles undergoing 15% depth of discharge and a 114% recharge.

(c) 93 cycles undergoing 25% depth of discharge and a 114% recharge.

During these tests, the oxygen pressure in the cell and the rate of heat generation by the cell were recorded. The enthalpy changes, corresponding to the reactions occurring during the charge and discharge processes, were calculated from the thermal data. These values were in excellent agreement with the literature values for these reactions.

The isothermal continuous flow calorimeter, developed for the thermal measurements, was calibrated over the range of 0.10 to 1.00 watt. This range is characteristic of the thermal output of a 6 ampere-hour Ni–Cd cell. The thermal response was found to be linear in this range and the instrument was sensitive to 0.01 watt. This is 28 times as sensitive as calorimeters previously used; temperature changes of 0.00096°C are detectable.

**Notes:**

1. Tech Brief B67-10615 contains information on the improved calorimeter.
2. Additional details are contained in *Research into Fundamental Phenomena Associated with Spacecraft Electrochemical Devices—Calorimetry of Nickel–Cadmium Cells*, by W. H. Webster and R. T. Foley, The American University, Washington, D.C. 20016. Copies of this report are available from:
   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland 20771
   Reference: B67-10614

**Patent status:**

No patent action is contemplated by NASA.

Source: W. H. Webster and R. T. Foley
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Category 01